

# New Hampshire Volunteer Lake Assessment Program

## 2002 Bi-Annual Report for Highland Lake Andover



NHDES  
Water Division  
Watershed Management Bureau  
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# OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **HIGHLAND LAKE, ANDOVER**, the program coordinators recommend the following actions.

Please remember the **Lake Sunapee Region Lab** is open at Colby Sawyer College in New London. This lab was established to serve the large number of lakes in the greater Lake Sunapee area. This lab is inspected by DES and operates under a DES approved quality assurance plan. If this lab is more convenient for your association, we encourage you to utilize this lab next summer for all sampling events (except for our annual visit, of course!). To find out more about the lab, and to schedule dates to pick up bottles and equipment, please call Bonnie Lewis, the lab manager, at (603) 526-3486.

## **FIGURE INTERPRETATION**

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration found in the water gives an estimation of the concentration of algae or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 ug/L.**

Similar to the summer of 2001, the summer of 2002 was filled with many warm and sunny days and there was a lower than normal amount of rainfall during the latter-half of the summer. The combination of these factors resulted in relatively warm surface waters throughout the state. The lack of fresh water to the lakes/ponds reduced the rate of flushing which may have resulted in water stagnation. Due to these conditions, many lakes and ponds experienced increased algae growth, including filamentous green

algae (the billowy clouds of green algae typically seen floating near shore), and some lakes/ponds experienced nuisance cyanobacteria (blue-green algae) blooms.

The current year data (the top graph) show that the chlorophyll-a concentration **decreased steadily** from June to August.

The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is **less than** the state mean.

Overall, the statistical analysis of the historical data show that the chlorophyll-a concentration has **significantly decreased** since monitoring began. Specifically, the chlorophyll-a concentration has **decreased** (meaning **improved**) on average **by approximately 3.4 percent** per sampling season during the sampling period **1987 to 2002**. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.) We hope this trend continues!

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Therefore, algal concentrations may increase when there is an increase in nonpoint sources of nutrient loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). It is important to continually educate residents about how activities within the watershed can affect phosphorus loading and lake quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

Two different weather related patterns occurred this past spring and summer that influenced lake quality during the summer season.

In late May and early June of 2002, numerous rainstorms occurred. Stormwater runoff associated with these rainstorms may have

increased phosphorus loading, and the amount of soil particles washed into waterbodies throughout the state. Some lakes and ponds experienced lower than typical transparency readings during late May and early June.

However, similar to the 2001 sampling season, the lower than average amount of rainfall and the warmer temperatures during the latter-half of the summer resulted in a few lakes/ponds reporting their best-ever Secchi-disk readings in July and August (a time when we often observe reduced clarity due to increased algal growth)!

The current year data (the top graph) show that the in-lake transparency **increased** from June to July, and then **decreased slightly** from July to August.

The historical data (the bottom graph) show that the 2002 mean transparency is **slightly greater than** the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual in-lake transparency has **not significantly changed** (either *increased* or *decreased*) since monitoring began in **1987**. Specifically, the in-lake transparency has **varied** (meaning **fluctuated**), but has not *continually increased* or *decreased* since monitoring began. It is important to note that the annual mean transparency has generally been **greater than** the state mean. We hope this continues! (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from NHDES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the**

**epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

The current year data for the epilimnion (the top inset graph) show that the total phosphorus concentration **increased very slightly** from June to July, and then **decreased** from July to August.

The historical data show that the 2002 mean epilimnetic total phosphorus concentration is **slightly less than** the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the total phosphorus concentration **decreased very gradually** from June to August.

The historical data show that the 2002 mean hypolimnetic total phosphorus concentration is **slightly less than** the state median.

Overall, the statistical analysis of the historical data show that the total phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has **not significantly changed** (either *increased* or *decreased*) since monitoring began in **1987**. Specifically, the total phosphorus concentration in the epilimnion and hypolimnion has **varied** (meaning **fluctuated**) but has not *continually increased* or *decreased* since monitoring began. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands. If you would like to educate watershed residents about how they can help to reduce phosphorus loading into the lake/pond, please contact the VLAP Coordinator.

#### **TABLE INTERPRETATION**

##### **➤ Table 2: Phytoplankton**

Table 2 lists the current and historic phytoplankton species observed in the lake/pond. The dominant phytoplankton species observed this year were ***Rhizosolenia* (a diatom), *Chrysosphaerella* (a golden-brown algae), and *Ceratium* (a dinoflagellate).**

Phytoplankton populations undergo a natural succession during the growing season (Please refer to page 12 of the "Biological Monitoring

Parameters” section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire’s less productive lakes and ponds. An overabundance of cyanobacteria (previously referred to as blue-green algae) indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria can be toxic to livestock, pets, wildlife, and humans.

➤ **Table 2: Cyanobacteria (Blue-green algae)**

Small amounts of the cyanobacterium *Microcystis*, *Anabaena*, and *Oscillatoria* were observed in the plankton sample this season. ***These species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.*** Cyanobacteria can reach nuisance levels when excessive nutrients and favorable environmental conditions occur.

As with the summer of 2001, we observed that some lakes and ponds had cyanobacteria present during the 2002 summer season, likely due to the many warm and sunny days that occurred this summer, which may have accelerated algal and bacterial growth. In addition, the lower than normal amount of rainfall during the latter half of the summer, meant that the slow flushing rates resulted in less phosphorus exiting the lake outlet and more phosphorus being available for plankton growth.

The presence of cyanobacteria serves as a reminder of the lake’s/pond’s delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading into the lake/pond by eliminating fertilizer use on lawns, keeping the lake/pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to “pile” cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

➤ **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is 6.5, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spot this season ranged from **6.14** in the hypolimnion to **6.78** in the epilimnion, which means that the water is ***slightly acidic***.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

➤ **Table 5: Acid Neutralizing Capacity**

Table 5 in Appendix B presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. For a more detailed explanation, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was **5.08 mg/L as CaCO<sub>3</sub>**, which is slightly less than the state mean (Table 5). Specifically, this means that the lake/pond is ***"moderately vulnerable"*** to acidic inputs (such as acid precipitation).

➤ **Table 6: Conductivity**

Table 6 in Appendix B presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. For a more detailed explanation, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The conductivity in the lake/pond and inlets (except for the **West Inlet**) is relatively ***low***.

The conductivity in the West Inlet was elevated on the July 31<sup>st</sup> sampling event (**101 uMhos/cm**). In addition, this station has had a

history of elevated conductivity levels. Typically conductivity levels greater than 100 uMhos/cm indicate the influence of human activities on surface water quality. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity. It is possible that the lower than normal amount rainfall during the latter-half of the summer reduced tributary and lake flushing, which allowed pollutants and ions to build up and resulted in elevated conductivity levels.

We recommend that your monitoring group conduct a stream survey and stormwater sampling along the **West Inlet** so that we can determine what may be causing the elevated levels. For a detailed explanation on how to conduct a stream survey and stormwater sampling, please refer to this year's "Special Topic Article" which is included in Appendix D of this report.

➤ **Table 8: Total Phosphorus**

Table 8 in Appendix B presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to page 17 of the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration in the **Lower Maple Brook** was elevated on the **July 8<sup>th</sup>** sampling event. The laboratory staff observed sediment in the sample bottle. The turbidity of the sample was also elevated. This suggests that the stream bottom may have been disturbed while sampling (Table 11). When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a "clean" sample.

The total phosphorus concentration *increased* in the **West Inlet** this season. This station has had a history of *fluctuating* total phosphorus concentrations. As discussed previously, we recommend that your monitoring group conduct stream surveys and stormwater sampling along this inlet.



➤ **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) for the 2002 sampling season. Table 10 shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

The dissolved oxygen concentration was **low in the hypolimnion** at the deep spot of the lake/pond. As stratified lakes/ponds age, oxygen becomes **depleted** in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (**as it was this season and in many past seasons**), the phosphorus that is normally bound up in the sediment may be re-released into the water column.

The **low** oxygen level in the hypolimnion is a sign of the lake’s/pond’s **aging** and **declining** health. This year the DES biologist conducted the temperature/dissolved oxygen profile in **July**. We recommend that the annual biologist visit for the 2003 sampling season be scheduled during **August** so that we can determine if oxygen is depleted in the hypolimnion **later** in the sampling season. (Please note that the dissolved oxygen has not been measured in the lake in August since 1987).

➤ **Table 11: Turbidity**

Table 11 in Appendix B lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to page 19 of the “Other Monitoring Parameters” section of this report for a more detailed explanation.

The turbidity was **elevated** in many of the inlet samples this season. This suggests that the stream bottom may have been disturbed while sampling or that soil erosion is occurring in the watershed. When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting samples in the inlets, please be sure to sample where there the stream is flowing and where the stream is deep enough to collect a “clean” sample.

## **DATA QUALITY ASSURANCE AND CONTROL**

### **Annual Assessment Audit:**

During the annual visit to your lake/pond, the biologist conducted a “Sampling Procedures Assessment Audit” for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor’s Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors are not following the proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an **excellent** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

### **Sample Receipt Checklist:**

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an **excellent** job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

## **NOTES**

**Laboratory Note (7/8/02):** The Lower Maple Street Brook Inlet sample had sediment in the bottle.

**Laboratory Note (7/31/02):** The conductivity and turbidity of the epilimnion sample was not run due to a laboratory error. We apologize for this error. The West Inlet sample has a dark color.

**Monitor's Note (8/27/02):** No samples from Maple St. Inlet or West Side Inlet because tributaries are dry.

### **USEFUL RESOURCES**

*Changes to the Comprehensive Shoreland Protection Act: 2001 Legislative Session*, NHDES Fact Sheet, (603) 271-3505, or [www.des.state.nh.us/factsheets/sp/sp-8.htm](http://www.des.state.nh.us/factsheets/sp/sp-8.htm)

*Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms*, NHDES Fact Sheet, (603) 271-3505, or [www.des.state.nh.us/factsheets/wmb/wmb-10.htm](http://www.des.state.nh.us/factsheets/wmb/wmb-10.htm)

*Managing Lakes and Reservoirs, Third Edition, 2001.* Prepared by the North American Lake Management Society (NALMS) and the Terrene Institute in cooperation with the U.S. Environmental Protection Agency. Copies are available from NALMS (internet: [www.nalms.org](http://www.nalms.org), phone 608-233-2836), and the Terrene Institute (internet: [www.terrene.org](http://www.terrene.org), phone 800-726-4853)

*Organizing Lake Users: A Practical Guide.* Written by Gretchen Flock, Judith Taggart, and Harvey Olem. Copies are available from the Terrene Institute (internet: [www.terrene.org](http://www.terrene.org), phone 800-726-4853)

*Proper Lawn Care in the Protected Shoreland: The Comprehensive Shoreland Protection Act*, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/sp/sp-2.htm](http://www.des.state.nh.us/factsheets/sp/sp-2.htm)

*Sand Dumping - Beach Construction*, WD-BB-15, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-15.htm](http://www.des.state.nh.us/factsheets/bb/bb-15.htm)

*Swimmers Itch*, WD-BB-2, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-2.htm](http://www.des.state.nh.us/factsheets/bb/bb-2.htm)

*Use of Lakes or Streams for Domestic Water Supply*, WD-WSEB-1-11, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/ws/ws-1-11.htm](http://www.des.state.nh.us/factsheets/ws/ws-1-11.htm)

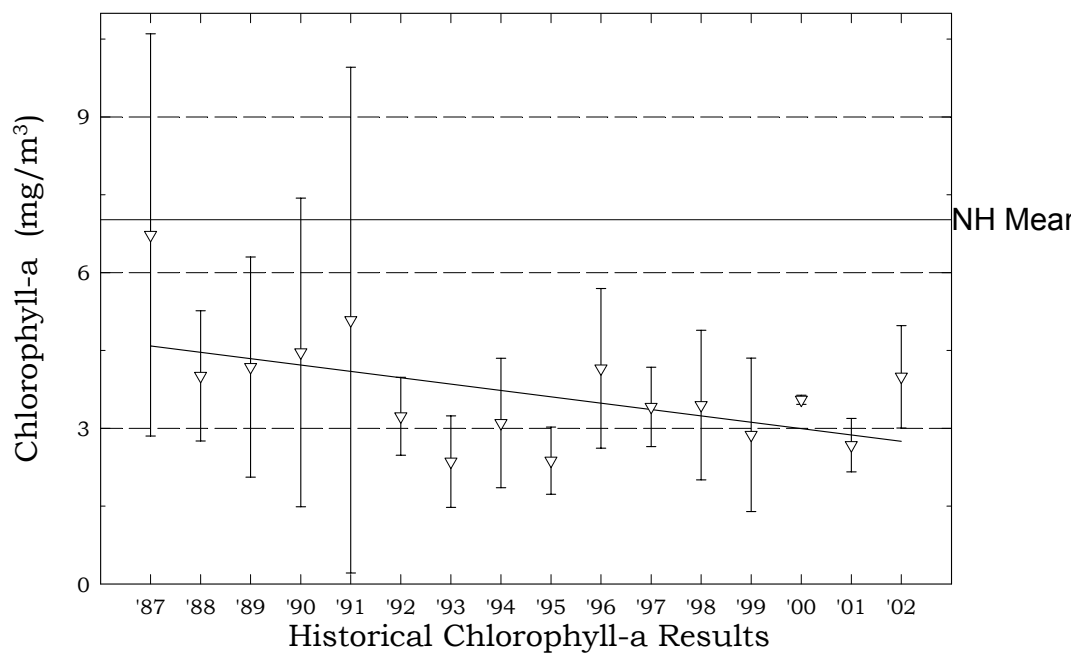
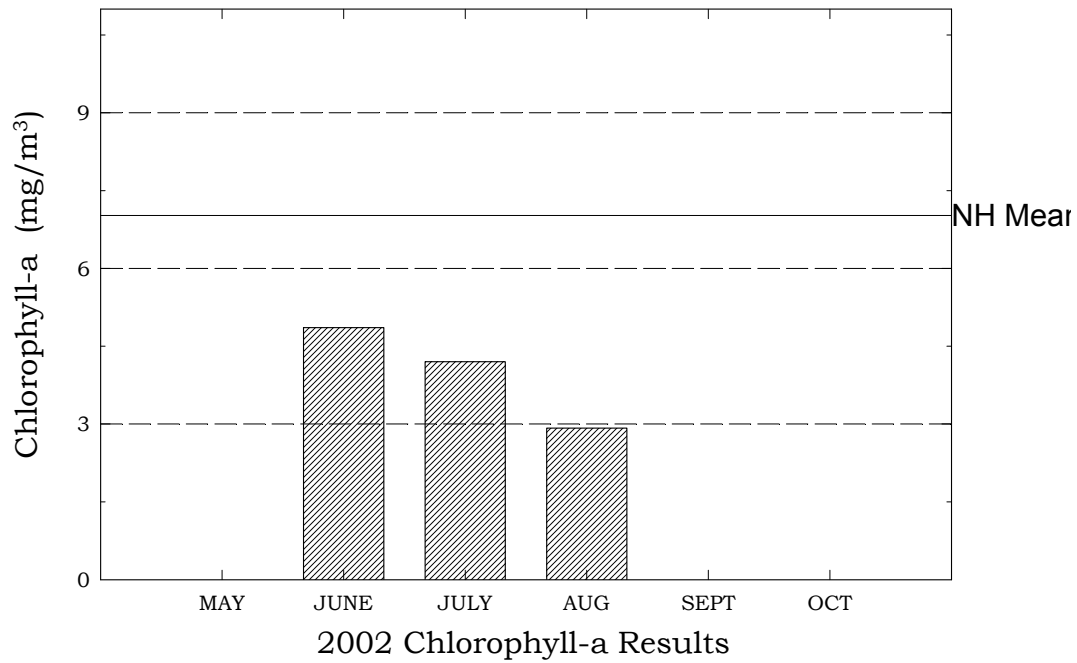
*Water Milfoil*, WD-BB-1, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-1.htm](http://www.des.state.nh.us/factsheets/bb/bb-1.htm)

*Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants*, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or [www.des.state.nh.us/factsheets/bb/bb-4.htm](http://www.des.state.nh.us/factsheets/bb/bb-4.htm)

# Appendix A: Graphs

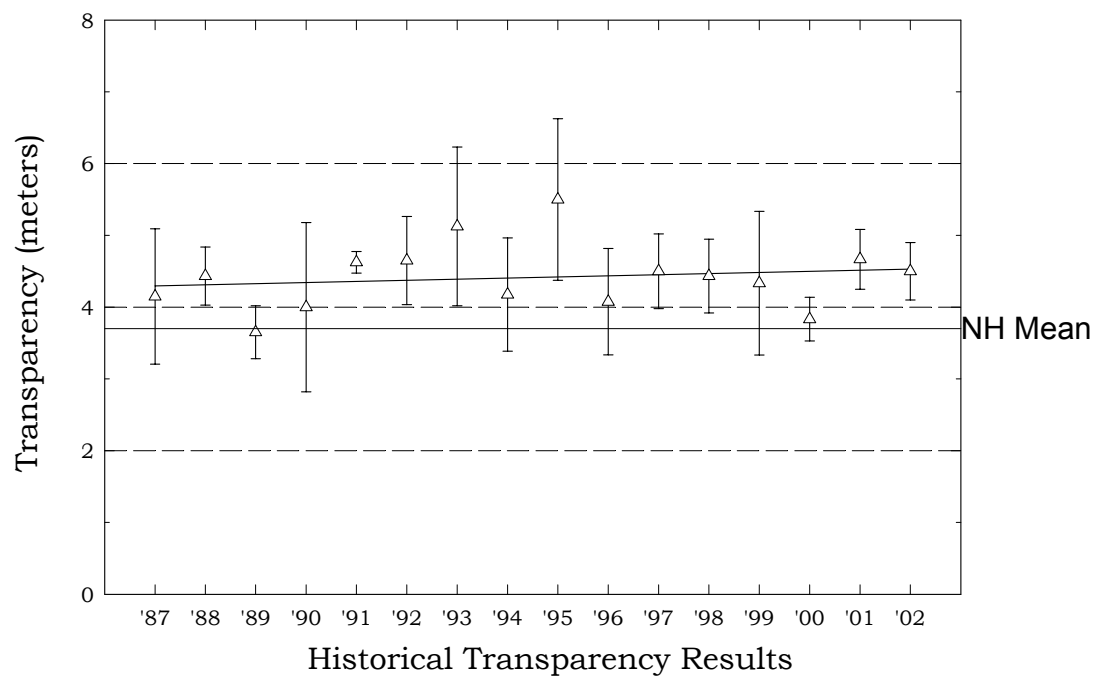
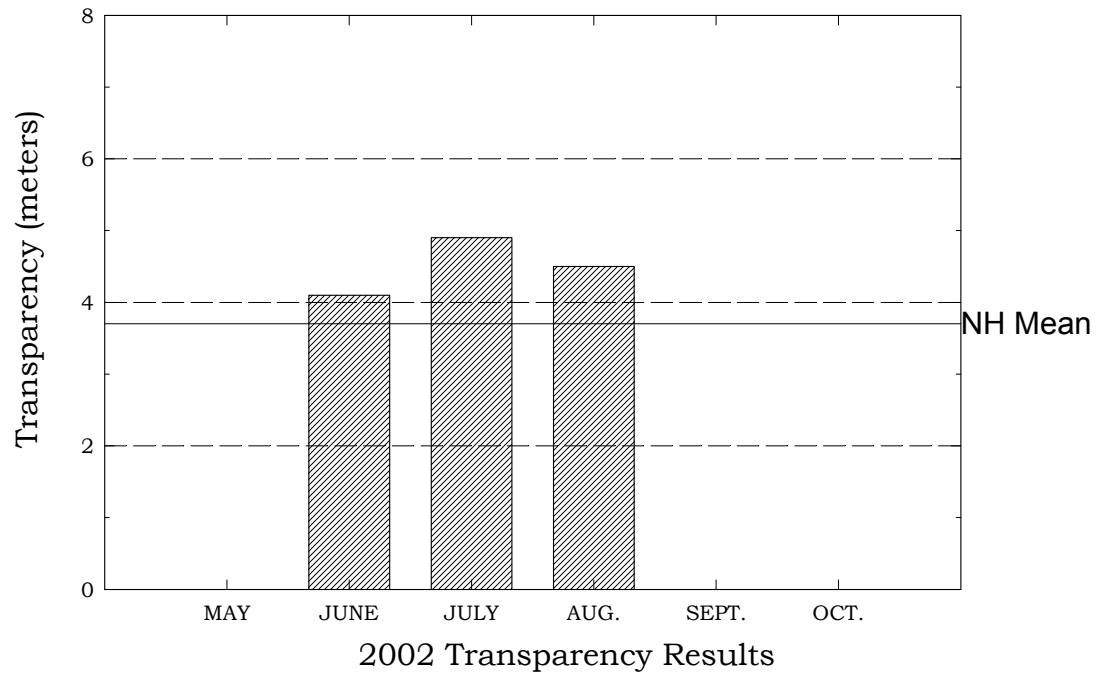
# Highland Lake, Andover

**Figure 1.** Monthly and Historical Chlorophyll-a Results



# Highland Lake, Andover

**Figure 2.** Monthly and Historical Transparency Results



# Highland Lake, Andover

**Figure 3.** Monthly and Historical Total Phosphorus Data.

